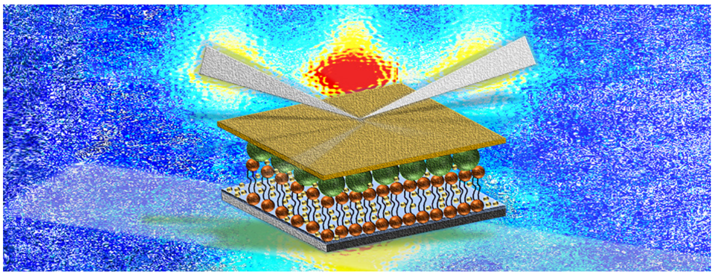

Beitrag ID: **16** Typ: **Invited talk**

Polarized neutron reflectometry on vertical and lateral magnetic domains in thin films

Freitag, 11. Oktober 2024 10:45 (30 Minuten)

Polarized neutron reflectometry (PNR) offers the possibility to resolve structural and magnetic morphologies of heterostructures and their interfaces as a function of depth with sub-nm resolution. In addition, lateral structures such as magnetic domains in the μm scale are accessible with off-specular scattering. This talk discusses two examples of functional thin films in which the formation of magnetic domains plays an important role.

The first example investigates the vector magnetization profile in high-anisotropy rare-earth alloys combined with soft magnetic Fe thin films. Such heterostructures form prime examples of exchange spring (ES) materials possessing high magnetizations and high magnetic anisotropy [1]. This promises a range of applications in logic circuits, sensor and magnetic storage technologies with high magnetic stability and durability. We use PNR to quantify the proximity coupling in $SmCo_5$/Fe and $NdCo_5$/Fe bilayers grown on Cr-buffered MgO substrates. Strong spin-flip signals of the neutron reflectometry as a function of field quantify the extension of moment canting away from the applied field towards the $SmCo_5$ interface. The case of $NdCo_5$/Fe is particularly intriguing due to its giant magnetocaloric effect and a spin-reorientation transition observed at 255 K [2]. PNR, recorded as a function of temperature and magnetic field orientation, shows a spiral moment configuration forming between the low and high temperature states.

In the second example, we investigate the lateral domain pattern of He-ion bombarded exchange bias thin films. Such artificially designed magnetic domain textures on micrometer length scales with controllable magnetization configurations present suitable templates for lab-on-a-chip applications, optically active surfaces, and biosensor devices [3]. Due to the absence of topographic height variations, guided positional control of magnetic particles is achieved solely from magnetic stray fields emerging from the domain walls of adjacent domains [4]. Polarized neutron scattering is used to resolve lateral periodicities, magnetization directions and disordered moments of the domains [5]. The measurements reveal crucial details about the magnetic pattern and the ordering of domain walls. The magnetic evolution is monitored during field cycling, providing a full picture of the magnetic configuration.

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Sitzung Einordnung: Functional magnetic thin films and heterostructures

Track Klassifizierung: Functional magnetic thin films and heterostructures